

the single reference of Cloud et al. (U.S. Pat. No. 5,653,619).

In the first Amendment and Response mailed November 15, 2001, Appellant amended claims 46 and 47-60 pursuant to 112 related issues.

In the second Office Action mailed March 26, 2002, claims 36-60 were rejected under 35 U.S.C. §103(a) as being unpatentable over the single reference of Cloud et al. (U.S. Pat. No. 5,653,619).

## **5. SUMMARY OF THE INVENTION**

An illustrative embodiment of the present invention includes a method for forming a self-aligned gate structure around an electron emitting tip. The method includes forming a cathode on a substrate. The cathode includes an emitter tip. An insulator layer is formed over the cathode and the emitter tip. The insulator is ion etched and a gate is formed on the insulator layer.

In another embodiment, a method of forming a field emission device on a substrate is provided. The method includes forming a cathode emitter tip in a cathode region of the substrate. A gate insulator layer is formed on the emitter tip and the substrate. An ion etch process is used in order to reduce the thickness of the gate insulator layer in the cathode region more rapidly than in the isolation region. Further, the method includes forming a gate on the gate insulator layer and an anode is formed opposing the emitter tip.

In another embodiment, a field emitter array is provided. The field emitter array includes a number of cathodes which are formed in rows along a substrate. A gate insulator is formed along the substrate and surrounds the cathodes. A number of gate lines are formed on the gate insulator. And, a number of anodes are formed in columns orthogonal to and opposing the rows of cathodes. The field emitter array is formed according to a method which includes the following: forming a number of cathode emitter tips in cathode regions of the substrate, forming a gate insulator layer on the emitter tips and the substrate such that forming the gate insulator layer includes ion etching the insulator layer such that the insulator layer is formed thinner around the emitter tips than in an isolation region of the substrate, forming a number of gate lines on the gate insulator layer, and forming a number of anodes opposite the emitter tips.

Thus, an improved structure and method are provided which will allow a smaller distance between the emitter tip and the gate structure without having to decrease the thickness of the gate dielectric which increases capacitance. A smaller emitter tip to gate distance lowers the turn-on voltage which is highly desirable in such areas as beam optics and power dissipation. The improved method and structure include the use of an energetic ion etch. Including the etch process removes portions of the sloped surface of a conformally covered emitter tip more rapidly than the flat portions of the gate isolation layer or surface. The method promotes a streamlined fabrication sequence and yields a structure with improved performance.

#### **6. ISSUES PRESENTED FOR REVIEW**

- A. Whether the drawing of the Cloud reference teach variations in thickness of an insulating layer.
- B. Whether the specification of the Cloud reference teach variations in thickness of an insulating layer that allow a portion of a gate layer to be closer to a cathode than a distance separating the gate layer from a substrate.

#### **7. GROUPING OF CLAIMS**

Claims 36-60 are to be considered separately for purposes of this appeal. Each claim should be reviewed separately, and the claims do not stand or fall together.

#### **8. ARGUMENT**

- A. **The drawings of the Cloud reference do not teach variations in thickness of an insulating layer.**

Applicant submits that the drawings of Cloud must be interpreted in light of the specification. The Examiner's rejection from the Office Action of August 15, 2001 states:

Cloud et al. further disclose that a distance separating the number of cathode emitter tips from the number of gate lines is significantly thinner than a separation distance separating the number of gate lines and the substrate (see Fig 1, Fig 2, and Fig 2B).

Applicant respectfully submits that the drawings must be interpreted in light of the specification. Pursuant to MPEP 2125 "proportions of features in a drawing are not evidence of actual proportions when drawings are not to scale." MPEP 2125 goes on to state that "when the reference does not disclose that the drawings are to scale and is silent as to dimensions, arguments based on measurements are of little value. However, the description of the article pictured can be relied on, in combination with the drawings, for what they would reasonable teach one of ordinary skill in the art."

The Cloud reference does not appear to indicate that the drawings are to scale, and the Cloud reference appears to be silent as to dimensions. Therefore, Applicant submits that the superficial appearance alone of Figures 1, 2, 2A and 2B does not support a 103(a) rejection in this matter.

**B. The specification of the Cloud reference teaches a preferably conformal layer and does not include a gate layer wherein a portion of the gate layer is closer to a cathode than a distance separating the gate layer from a substrate.**

*The specification of Cloud does not include variations in insulator layer thickness and Cloud teaches away from varying an insulator layer thickness.*

As stated in MPEP 2125, "the description of the article pictured can be relied on, in combination with the drawings, for what they would reasonable teach one of ordinary skill in the art." The specification of the Cloud reference appears to discuss a careful process of choosing a uniform thickness for the **conformal** insulating layer in column 5, lines 42-50.

The thickness of this first insulating layer 18 will substantially determine **both** the gate 15 to cathode 13 spacing, **as well as** the gate 15 to substrate spacing 11. Hence, the insulating layer 18 must be as thin as possible, since small gate 15 to cathode 13 distances result in lower emitter drive voltages, **at the same time**, the insulating layer 18 must be large enough to prevent the oxide breakdown which occurs if the gate is not adequately spaced from the cathode conductor 12.

Cloud **does not teach variations in thickness** of the insulating layer 18. It merely teaches that the single uniform thickness chosen must be chosen with certain performance factors in mind as discussed in the Cloud quotation above. In fact, Cloud teaches away from varying the thickness of the insulating layer 18 as cited by the Examiner when Cloud states that the insulating layer is **preferably** conformal (col. 5, line 62).

A gate layer 15 appears to be deposited over the preferably conformal insulating layer 18. Because the preferably conformal insulating layer is uniform in thickness, and no material has been removed from the insulating layer, the distance separating the gate lines from the substrate is equal to the uniform thickness of the insulating layer. Because the thickness of the insulating layer is uniform, it is impossible for any portion of the gate layer 15 to be closer to the cathode 13 than the distance separating the gate lines from the substrate.

*The Examiner's interpretation of Cloud*

On page 8 of the Office Action mailed August 15, 2001, and in the Office Action mailed March 26, 2002, reference is made to a portion of the specification of Cloud. However, the citation (col. 5, lines 52-55) appears to have been misunderstood. The rejection states:

Cloud teaches that the insulating layer 18 can be deposited to a level substantially equal to or slightly higher than the level of the cathode tips (Lines 52-55 of column 5). In the case, when it is deposited at the level of cathode tip, thickness of the insulating layer 18 above the cathode tip is zero while the thickness of the insulating layer at other locations has a definite value.

A conformal layer as specifically taught by Cloud, by definition, does not vary in thickness. The misunderstanding of Cloud in the pending Office Action appears to arise where Cloud refers to depositing the insulating layer 18 to a level in comparison to the cathode emitter 13. Cloud refers to a level of the cathode emitter 13. One skilled in the art will recognize this as a distance between the base of the cathode emitter 13 and the tip of the cathode emitter. Cloud also refers to a level of the insulating layer 18. One skilled in the art will recognize this as a thickness of the conformal insulating layer 18 in a region spaced apart from the cathode emitter 13. When Cloud describes depositing the insulating layer 18 to a level equal to the level of the cathode emitter 13, the insulating layer level referred to is understood to be an average of the

regions that are spaced apart from the emitter tip 13 itself. In the local region of the cathode emitter, one skilled in the art will recognize that the conformal insulating layer 18 maintains its thickness as it "conforms to the shape of the cathode emitter tip 13" (col. 5, line 64).

Applicant is unable to understand how the word "conformal" as specifically taught in Cloud (col. 5, lines 62 and 64) can be used to describe the proposed interpretation with varied layer thicknesses as hypothesized by the Examiner in the August 15, 2001, and March 26, 2002 Office Actions. One skilled in the art will recognize that deposition methods such as CVD used to form insulating layers 18 are only capable of forming conformal layers. Deposited layers uniformly coat surface features at the same rate. They do not operate under "flow" mechanisms to fill the lowest surface areas first. Variations in thickness of insulating layers are not taught in Cloud, nor are they obvious without teaching as found in the present application.

In contrast, Applicant's invention includes a field emitter array where the distance separating the number of cathode emitter tips from the number of gates lines is significantly thinner than a separation distance separating the number of gate lines and the substrate. This configuration is impossible without varying a thickness of the insulating layer as taught in the present application.

## **9. SUMMARY**

Because the Figures 1, 2, 2A and 2B of Cloud cited in the pending Office Action do not appear to be designated as being to scale, and no dimensions appear to be included, the Figures alone do not support a 35 USC § 103(a) rejection. When interpreted in light of the specification of Cloud, a conformal insulator layer is shown. The conformal insulator layer makes it impossible for Cloud to show a distance separating the number of cathode emitter tips from the number of gates lines that is significantly thinner than a separation distance separating the number of gate lines and the substrate. Reconsideration and withdrawal of Examiner's 35 USC § 103(a) rejection is respectfully requested.